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(54) **TELESCOPIC HYDRAULIC CYLINDER**

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F15B 15/14 (2006.01)

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CPC ***F15B 15/16*** (2013.01); *F15B 15/1471* (2013.01)

(58) **Field of Classification Search**
CPC ... F15B 15/16; F15B 15/1471; F15B 15/1423
USPC 92/51, 52, 53
See application file for complete search history.

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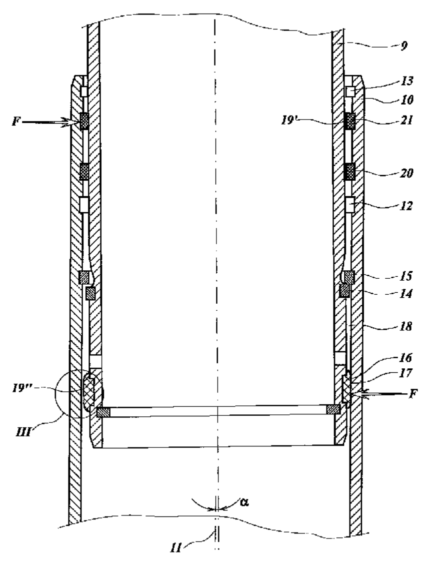
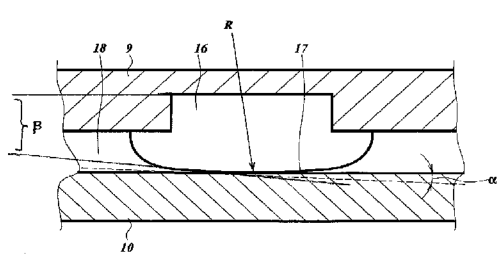
(57) **ABSTRACT**

A telescopic hydraulic cylinder includes an inner cylindrical tube and an outer cylindrical tube located concentrically about the inner cylindrical tube, and a guide ring for guiding the inner and outer cylindrical tubes. The guide ring has a cylindrical support surface with a center line and a guide surface and is mounted in a cylindrical groove. The guide surface slides along the inner surface of the outer cylindrical tube or the outer surface of the inner cylindrical tube. The guide surface has a curved surface with a curve radius and a tangent and the tangent to the curved surface and the center line form an inclination angle between zero and five degrees, and the curve radius is larger than the radius of the guide ring in the plane perpendicular to the center line.

16 Claims, 4 Drawing Sheets





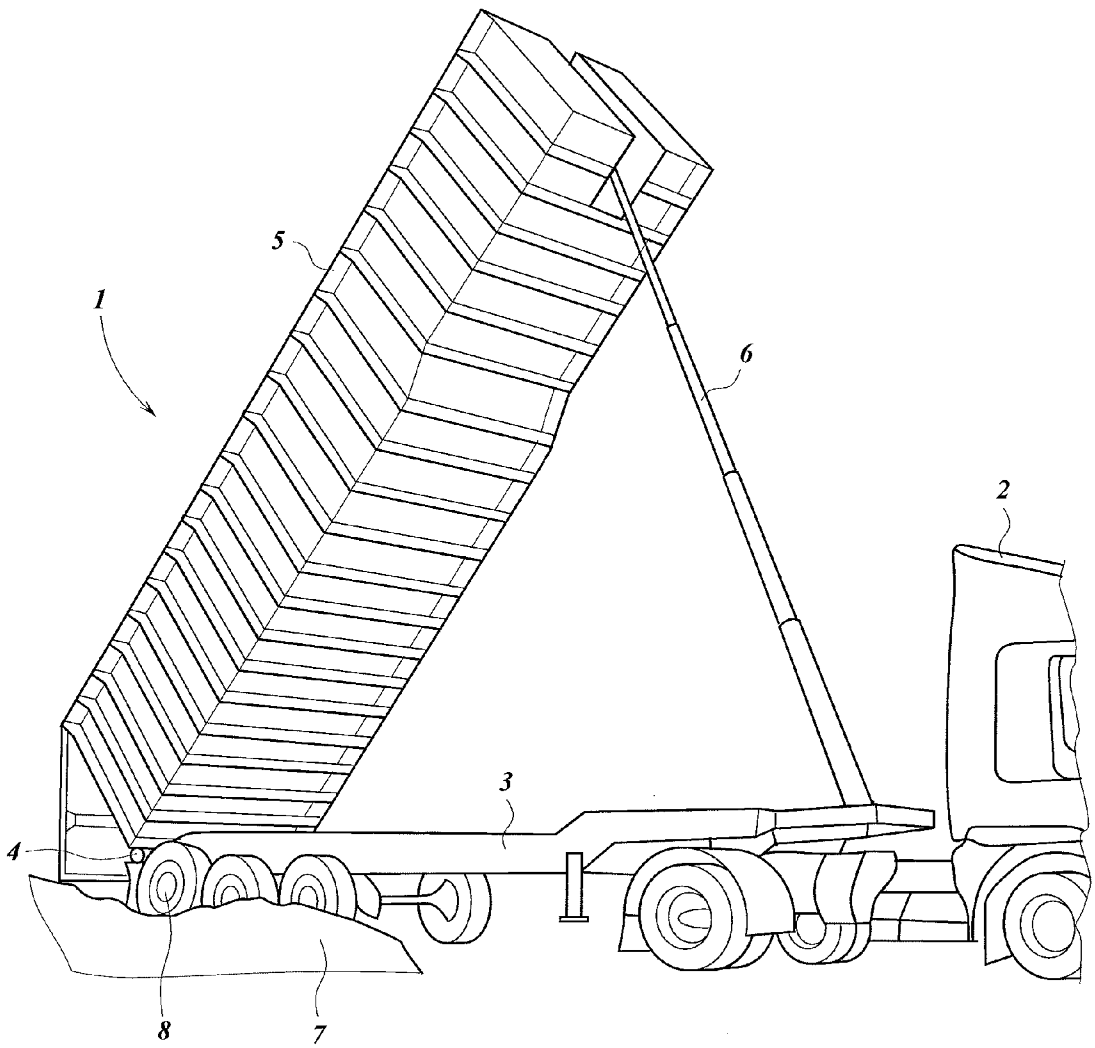


Fig. 1

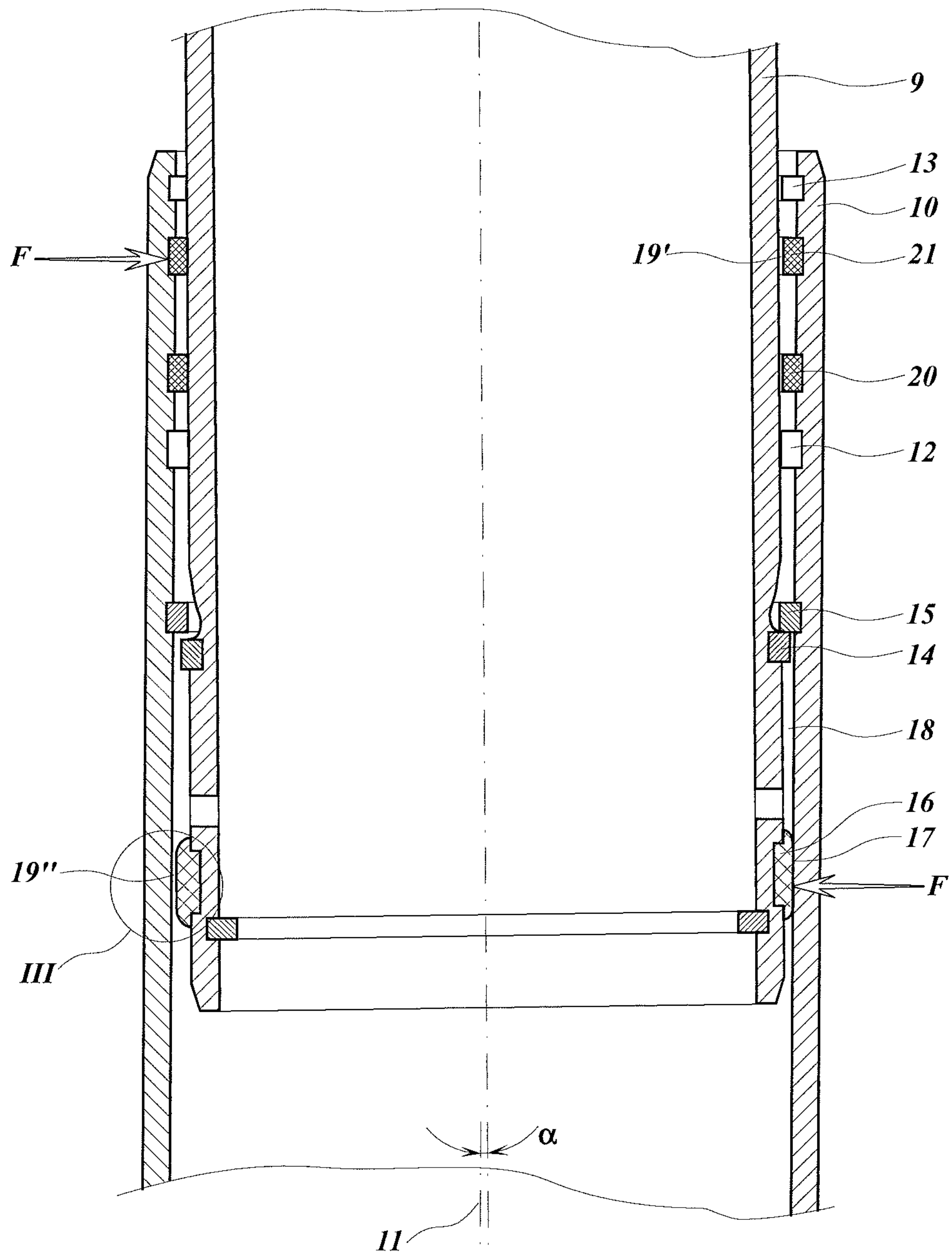


Fig.2

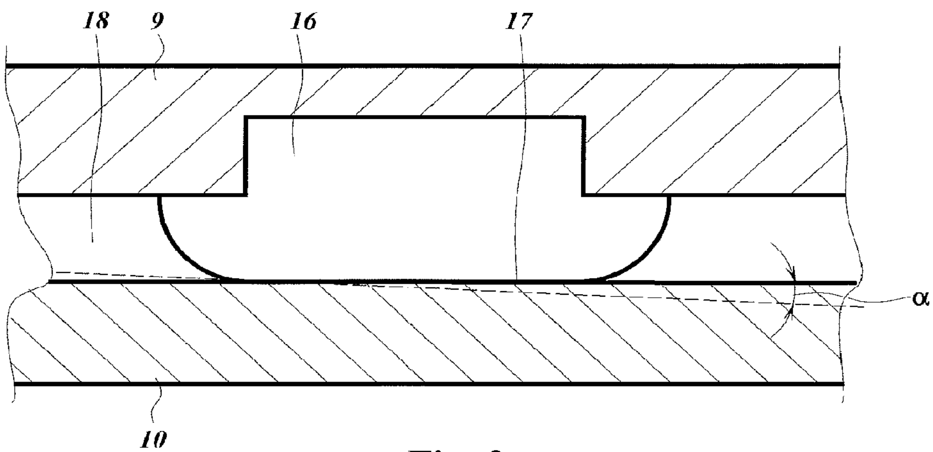


Fig. 3
(Prior Art)

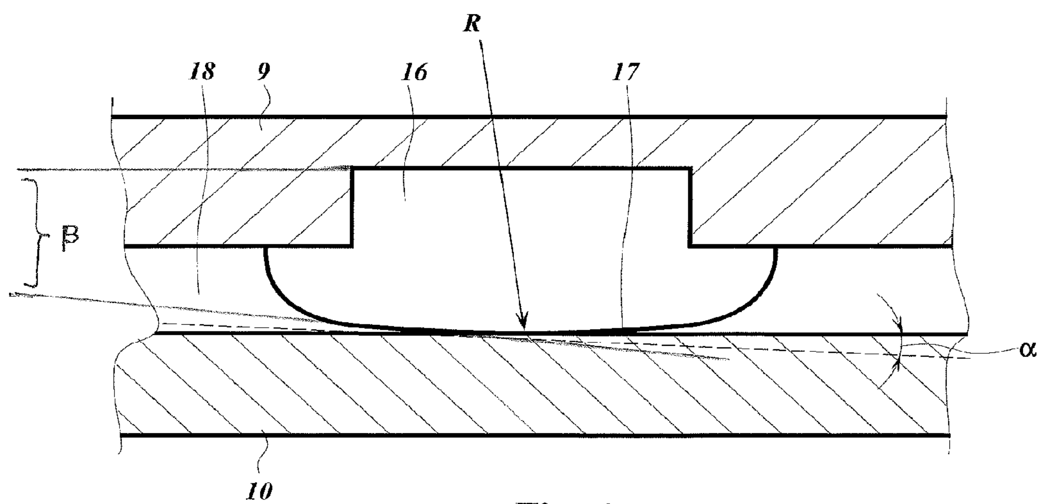


Fig. 4

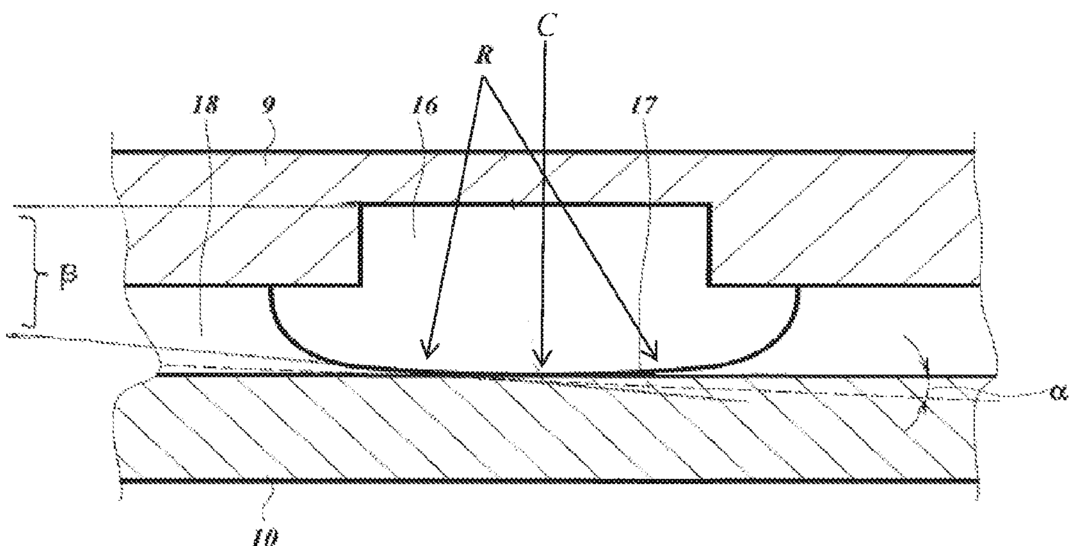


Fig. 5

TELESCOPIC HYDRAULIC CYLINDER

PRIORITY CLAIM(S) AND/OR CROSS REFERENCE(S) TO RELATED APPLICATION(S)

This application is an original application under 35 U.S.C. §111(a) claiming priority to European Application No. 11185968.2, filed Oct. 20, 2011, whose application and publication are incorporated herein by reference and made a part hereof in its entirety, and the benefit of priority of which is claimed herein.

FIELD OF INVENTION

The present disclosure relates to a telescopic hydraulic cylinder.

SUMMARY

The present invention relates to a telescopic hydraulic cylinder, comprising an inner cylindrical tube and an outer cylindrical tube located concentrically around the inner cylindrical tube, and a guide ring for guiding the inner and outer cylindrical tubes while moving in longitudinal direction with respect to each other, the guide ring has a cylindrical support surface with a centre line and a guide surface and is mounted with its cylindrical support surface in a cylindrical groove in either the outer surface of the inner cylindrical tube or the inner surface of the outer cylindrical tube and the guide surface slides along the inner surface of the outer cylindrical tube or the outer surface of the inner cylindrical tube respectively.

Such a telescopic hydraulic cylinder is discussed in European patent application EP2466156, which was filed by the same applicant as the applicant of the present application.

It is an object of the present invention to provide a telescopic hydraulic cylinder, which has increased durability.

This is achieved by the telescopic hydraulic cylinder according to the disclosure, which is characterized in that the guide surface has in a plane that includes the centre line a curved surface with a curve radius an a tangent and the tangent to the curved surface and the centre line form a tangent angle; wherein the tangent angle is between zero and five degrees and possibly between zero and two degrees and the curve radius is larger than the radius of the guide ring in the plane perpendicular to the centre line. In this way in situations with small alignment faults between the inner cylindrical tube and the outer cylindrical tube the contact between the guide surface and the opposite inner cylindrical tube or outer cylindrical tube is between a cylindrical surface and a curved surface with a large curve radius instead of between a cylindrical surface and a sharp edge, so that high tension stress is avoided and a better durability of the guide ring and the cylindrical tube is achieved.

In an embodiment, the telescopic hydraulic cylinder is according to claim **2**. In this way, the guide ring can have a fully curved guide surface or a large width, which reduces the contact stress between the guide ring and the inner or outer cylindrical tubes.

In an embodiment, the telescopic hydraulic cylinder is according to claim **3**. In this way the surface stress on the guide ring is further reduced which improves the durability of the guide ring.

In an embodiment, the telescopic hydraulic cylinder is according to claim **4**. In this way, the fillets prevent high loads on the ends of the guide ring.

In an embodiment, the telescopic hydraulic cylinder is according to claim **5**. In this way, the oil in the hydraulic cylinder lubricates the sliding between the inner surface of the inner cylindrical tube or the surface of the outer cylindrical tube and the guiding surface of the guide ring.

In an embodiment, the telescopic hydraulic cylinder is according to claim **6**. In this way, high stresses on the not lubricated surface of the wear ring are avoided.

The invention will hereafter be elucidated with reference to the schematic drawings showing an embodiment of the invention by way of example.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of a tipper with a telescopic hydraulic cylinder lifting a tipping body.

FIG. **2** is a detailed cross-sectional view through a centre line of a part of the telescopic hydraulic cylinder of FIG. **1**, illustrating the transition between an inner cylindrical tube and an outer cylindrical tube in an extended position of the telescopic hydraulic cylinder.

FIG. **3** shows detail III of FIG. **2** according to the prior art.

FIG. **4** shows detail III of FIG. **2** according to an embodiment of the invention.

FIG. **5** shows detail III of FIG. **2** according to another embodiment of the invention.

DETAILED DESCRIPTION

FIG. **1** shows a tipper **1** comprising a tractor **2** and a trailer **3**. A hinge **4** connects a frame of the trailer **3** and a tipping body **5** and a telescopic hydraulic cylinder **6** can lift the tipping body **5** to a tilted position for unloading the tipping body **5**. The trailer **3** has axles with wheels to support the frame of the trailer **3** on the terrain. The terrain might have mounds **7**, so that a rear axle **8** and with that the hinge **4** can be slightly inclined whereby the trailer **3** has a slight twist. The inclination of the hinge **4** can cause sideways movement of the tipping body **5** relative to the trailer **3** and in extreme situations this might lead to rolling over of the tipper **1** after the telescopic hydraulic cylinder **6** lifts the tipping body **5**. By giving support to the tipping body **5** in a direction transverse to the trailer **3**, the telescopic hydraulic cylinder **6** reduces the sideways movement to the tipping body **5** relative to the trailer **3** during tipping. For this, the telescopic hydraulic cylinder **6** can exert a transversal force on the tipping body **5**.

FIG. **2** shows a part of the telescopic hydraulic cylinder **6** of FIG. **1**, in particular the transition between an inner cylindrical tube **9** and an outer cylindrical tube **10**. The telescopic hydraulic cylinder **6** is described in more detail in a European application of the same applicant with publication number EP 2466156. In FIG. **2**, several parts of the telescopic hydraulic cylinder **6** are not shown, for example a piston, hydraulic channels and other tubes or cylinder elements.

The inner cylindrical tube **9** and the outer cylindrical tube **10** are each made of a pipe and located concentrically about around each other. Between the inner cylindrical tube **9** and the outer cylindrical tube **10** is a gap **18**. Near the top end of an inner wall of the outer cylindrical tube **10** is a groove into which a seal **12** is mounted to seal the gap **18** from the surroundings. The seal **12** can slide over an outer wall of the inner cylindrical tube **9**. Further to the top end of the inner wall of the outer cylindrical tube **10** is a groove into which a wiper **13** is mounted to remove contamination from the outer wall of the inner cylindrical tube **9** to prevent dirt from entering into the gap **18** and damaging the seal **12**. An upper wear ring **21** and a lower wear ring **20** are mounted in grooves in the outer cylindrical tube **10** between the seal **12** and the wiper **13** at an end of the outer cylindrical tube **10** and support the outer cylindrical tube **10** on the outside surface of the inner cylindrical tube **9** so that the seal **12** is not compressed too far and remains flexible.

In the embodiment as shown, the inner cylindrical tube **9** is moveable with respect to the outer cylindrical tube **10** between a retracted condition and an extended condition. Under operating conditions, supplying hydraulic pressure to the telescopic hydraulic cylinder **6** moves the inner cylindrical tube **9** upwardly with respect to the outer cylindrical tube **10**. FIG. **2** shows the extended condition. In this embodiment, the pair of stop rings **14**, **15**, which are mounted in grooves in the outer wall of the inner cylindrical tube **9** and the inner wall of the outer cylindrical tube **10** respectively, stop the upward movement of the inner cylindrical tube **9**.

The upper wear ring **21** and the lower wear ring **20** that guide the axial movement of the inner cylindrical tube **9** within the outer cylindrical tube **10** are made from plastic material that has good sliding properties over the outer surface of the inner cylindrical tube **9**, this is advantageous as they are outside of the gap **18** and there is no oil lubrication. The wear rings **20**, **21** are mounted in grooves that are located near the top end of the outer cylindrical tube **10**. In the shown embodiment there are two wear rings **20**, **21**. In other embodiments the number of wear rings can be different, for instance only one wear ring or up to six wear rings; other materials than plastic are also used.

A further guidance is by means of a guide ring **16**; in an embodiment the guide ring **16** is from metal so that it maintains the width of the gap **18** over the full circumference, cannot be compressed and shows little wear. The guide ring **16** is located in the gap **18** between the inner and outer cylindrical tubes **9**, **10** and mounted in a cylindrical groove in the outer wall of the inner cylindrical tube **9**; the cylindrical groove has a centre line **11** which in general coincides with the centre line of the inner cylindrical tube **9** and with the centre line of the inner surface of the guide ring **16**. A guide surface **17** of the guide ring **16** is slidable along the inner wall of the outer cylindrical tube **10** and the oil in the telescopic hydraulic cylinder **6** lubricates the sliding between the guide surface **17** and the inner wall of the outer cylindrical tube **10**. In an embodiment, the guide ring **16** is from cast iron. At both ends of the guide ring **16** the guide surface **17** ends in a fillet towards the sides of the guide ring **16**, so that there is a gradual end to the guide surface **17**. In the shown embodiment the radius of the fillet is approximately the same as the width of the gap **18**.

As described hereinbefore there may be a transverse load on the telescopic hydraulic cylinder **6** in addition to a buckling force during lifting the tipper body **5**. Therefore, in the extended condition, the inner cylindrical tube **9** exerts a torque on the outer cylindrical tube **10**; two force vectors F indicate this torque in FIG. **2** at the location of the upper wear ring **21** and the guide ring **16**. The force F on the wear ring **21** removes the play at one side of the wear ring **21** and creates an aperture **19'** at the other side of the wear ring **21**. The force F on the guide ring **16** removes the play at one side of the guide ring **16** and creates an aperture **19"** at the other side of the guide ring **16**. The forces F also lead to deformation of the circular shape of the inner cylindrical tube **9** and the outer cylindrical tube **10** so that the round cross section deforms to a slightly elliptical cross section. The apertures **19'** and **19"** and the slight deformation lead to a misalignment angle α between the actual centre line of the inner cylindrical tube **9** and the actual centre line of the outer cylindrical tube **10**; FIG. **2** shows this misalignment angle α.

This means that the centre line of the inner cylindrical tube **9** and the centre line of the outer cylindrical tube **10** are out of line, although the misalignment angle α is very small in practice, for example smaller than 0.5°. Under circumstance the misalignment angle α might reach a higher value such as 1.0° or possibly 1.5°. When the inner cylindrical tube **9** moves in longitudinal direction relative to the outer cylindrical tube **10** and the guide ring **16** exerts a force onto the inner wall of the outer cylindrical tube **10** whereby the angle α is larger than zero the load concentrates at one of the sides of the guide ring **16** if the guiding surface **17** of the guide ring **16** is cylindrical and parallel to the centreline of the inner cylindrical tube **9**. FIG. **3** shows this situation with a guide ring **16** that has fillets at both sides. The fillets have a relatively small radius that is approximately equal to the width of the gap **18**. The relatively small fillets lead to high surface stress between the guide ring **16** and the inner surface of the outer cylindrical element **10**. This high stress might lead to damage and/or abrasive wear to the guide ring and/or the outer cylindrical tube **10**.

In order to reduce or avoid abrasive wear of the guide ring **16** during sliding in the outer cylindrical tube **10** in the embodiment according to the invention the guide surface **17** is convex over a curved surface of the guide ring **16** in a direction parallel to its centre line **11** and has over this curved surface a radius R that is larger than the radius of the guide ring **16** in a plane perpendicular to the length of the tube. FIG. **4** shows the tangent t to the curved surface; the tangent t makes a tangent angle β with the centre line **11** and the maximum value of the tangent angle β is larger that the misalignment angle α. In some embodiments the radius is larger than 0.10 m or larger than 0.20 m. As shown in the embodiment of the guide ring **16** in accordance with the invention, see FIG. **4**, the guide ring **16** can have at both ends of the support width of the guide ring **16** a fillet for ease of mounting. The large radius R of the curved surface leads to a reduced surface stress and this avoids abrasive wear.

It will be clear that the curved surface with the large radius R can be at both sides or ends of the guide ring **16** and can be adjacent to each other or the guide surface **17** is for a part cylindrical portion "C" and portions at both sides with the curved surfaces R as illustrated in FIG. **5**.

In further embodiments, not shown, the guide ring **16** ends without fillet and has a rectangular cross section with a convex guide surface **17**. In order to prevent high surface stress, the cross section of the guide ring **16** has a curve radius R that is at least the radius of the guide ring **16** in the plane of the cross section in that part of the guide surface **17** where the tangent t to the guide surface **17** makes a tangent angle β that is at least 2 or possibly at least 5 degrees with the centre line **11** so that in case alignment faults with a misalignment angle α of upto 2 degrees or possibly upto 5 degrees the guide surface **17** contacts the opposite cylindrical surface with a sufficient large curve radius R.

Embodiment 1

Telescopic hydraulic cylinder (**6**), comprising an inner cylindrical tube (**9**) and an outer cylindrical tube (**10**) located concentrically around the inner cylindrical tube, and a guide ring (**16**) for guiding the inner and outer cylindrical tubes (**9**, **10**) while moving in longitudinal direction with respect to each other, the guide ring (**16**) has a cylindrical support surface with a centre line (**11**) and a guide surface (**17**) and is mounted with its cylindrical support surface in a cylindrical groove in either the outer surface of the inner cylinder or the inner surface of the outer cylindrical tube and the guide surface slides along the inner surface of the outer cylindrical tube or the outer surface of the inner cylindrical tube respectively, wherein the guide surface (**17**) has in a plane that includes the centre line (**11**) a curved surface with a curve radius (R) and a tangent (t) and the tangent to the curved surface and the centre line form an tangent angle (β); wherein the tangent angle is between zero and five degrees and possibly between zero and two degrees and the curve radius (R) is larger than the radius of the guide ring (**16**) in the plane perpendicular to the centre line.

Embodiment 2

A telescopic hydraulic cylinder (**6**) according to embodiment 1 wherein the guide ring (**16**) has at each side a curved surface and the curved surfaces are adjacent or connected by a cylindrical surface.

Embodiment 3

A telescopic hydraulic cylinder (**6**) according to embodiment 1 or 2, wherein the curved radius (R) is at least 0.10 m or possibly at least 0.20 m.

Embodiment 4

A telescopic hydraulic cylinder (**6**) according to embodiment 1, 2 or 3, wherein the guide surface (**17**) has adjacent to the curved surface a fillet.

Embodiment 5

A telescopic hydraulic cylinder (**6**) according to embodiment 1, 2, 3 or 4, wherein a seal (**12**) seals an oil filled gap (**18**) between the inner cylindrical tube (**9**) and the outer cylindrical tube (**10**) and the guide ring (**16**) is located in the oil filled gap.

Embodiment 6

A telescopic hydraulic cylinder (**6**) according to embodiment 5, wherein a wear ring (**20**,**21**) is provided outside the oil filled gap (**18**) and the wear ring has a guide surface with a curved surface like the guide surface (**17**) of the guide ring (**16**) and the wear ring might be of plastic.

The invention is not limited to the embodiment shown in the drawings and described hereinbefore, which may be varied in different manners within the scope of the claims. It is, for example, conceivable that the guide ring **16** is fixed in the outer cylindrical tube **10** instead of the inner cylindrical tube **9** and/or that the wear rings **20**,**21** are also provided with convex guide surfaces.

The invention claimed is:

1. A telescopic hydraulic cylinder, comprising:

an inner cylindrical tube;

an outer cylindrical tube located concentrically around the inner cylindrical tube; and

a guide ring for guiding the inner and outer cylindrical tubes while moving in longitudinal direction with respect to each other,

wherein a first side of the guide ring has a cylindrical support surface with a center line and wherein a second opposing side of the guide ring has a guide surface, wherein the guide ring is mounted with its cylindrical support surface located in a cylindrical groove in either the outer surface of the inner cylinder or the inner surface of the outer cylindrical tube, and wherein the guide surface is configured to slide over the inner surface of the outer cylindrical tube or the outer surface of the inner cylindrical tube respectively;

wherein a cross-section of the guide surface in a plane that includes the center line comprises a curved profile which has a radius of curvature larger than a radius of the guide surface of the guide ring in a plane perpendicular to the center line; and

wherein all tangent lines to the curved profile form a tangent angle with the center line of between zero and five degrees.

2. The telescopic hydraulic cylinder according to claim **1**, wherein all tangent lines to the curved profile form a tangent angle with the center line of between zero and two degrees.

3. The telescopic hydraulic cylinder according to claim **1**, wherein the radius of curvature of the curved profile is at least 0.10 m.

4. The telescopic hydraulic cylinder according to claim **1**, wherein the radius of curvature of the curved profile is at least 0.20 m.

5. The telescopic hydraulic cylinder according to claim **1**, wherein the guide surface has a fillet adjacent to the curved profile.

6. The telescopic hydraulic cylinder according to claim **1**, further comprising a seal sealing an oil filled gap between the inner cylindrical tube and the outer cylindrical tube and wherein the guide ring is located in the oil filled gap.

7. The telescopic hydraulic cylinder according to claim **6**, further comprising a wear ring provided outside the oil filled gap and wherein the wear ring has a guide surface with a curved profile matching the curved profile of the guide surface of the guide ring.

8. The telescopic hydraulic cylinder according to claim **7**, wherein the wear ring is of plastic.

9. A telescopic hydraulic cylinder, comprising:

an inner cylindrical tube;

an outer cylindrical tube located concentrically around the inner cylindrical tube; and

a guide ring for guiding the inner and outer cylindrical tubes while moving in longitudinal direction with respect to each other,

wherein a first side of the guide ring has a cylindrical support surface with a center line and wherein a second opposing side of the guide ring has a guide surface, wherein the guide ring is mounted with its cylindrical support surface located in a cylindrical groove in either the outer surface of the inner cylinder or the inner surface of the outer cylindrical tube, and wherein the guide surface is configured to slides over the inner surface of the outer cylindrical tube or the outer surface of the inner cylindrical tube respectively;

wherein a cross-section of the guide surface in a plane that includes the center line comprises a linear profile center portion disposed between curved profile portions, each curved profile portion having a radius of curvature larger than a radius of the guide surface of the guide ring in a plane perpendicular to the center line; and

wherein all tangent lines to the curved profile portions form a tangent angle with the center line of between zero and five degrees.

10. The telescopic hydraulic cylinder according to claim **9**, wherein the radius of curvature of each curved profile portion is at least 0.10 m.

11. The telescopic hydraulic cylinder according to claim **9**, wherein the radius of curvature of each curved profile portion is at least 0.20 m.

12. The telescopic hydraulic cylinder according to claim **9**, wherein the guide surface has a fillet adjacent to each curved profile on a side opposite the linear profile center portion.

13. The telescopic hydraulic cylinder according to claim **12**, further comprising a seal sealing an oil filled gap between the inner cylindrical tube and the outer cylindrical tube and wherein the guide ring is located in the oil filled gap.

14. The telescopic hydraulic cylinder according to claim **13**, further comprising a wear ring provided outside the oil filled gap and wherein the wear ring has a guide surface with a curved profile matching the curved profiles portions of the guide surface of the guide ring.

15. The telescopic hydraulic cylinder according to claim **14**, wherein the wear ring is of plastic.

16. The telescopic hydraulic cylinder according to claim **9**, wherein all tangent lines to each curved profile portions form a tangent angle with the center line of between zero and two degrees.

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